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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/660,573	09/12/2003	Ming-Tsong Wang	0941-0841P	5290

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BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

EXAMINER	
MALDONADO, JULIO J	
ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 10/05/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/660,573	WANG ET AL.	
	Examiner	Art Unit	
	Julio J. Maldonado	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 July 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9,11,15,16 and 18-40* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-9,11,15,16 and 18-40* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. The rejection of claims 1-40 in the Office Action mailed on 04/21/2004 is withdrawn in view of applicants' amendments.

2. The cancellation of claims 10, 12-14 and 17 is acknowledged.

3. Claims 1-9, 11, 15, 16 and 18-40 are pending in the application.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1-3, 5-9, 11, 15, 16, 26 and 29-33 are rejected under 35 U.S.C. 102(e) as being anticipated by Smith et al. (U.S. 2003/0224595).

Smith et al. (Figs.3-12) teach a related method for forming a metal damascene structure including forming a cap layer (108a) over a copper layer (106), wherein said cap layer (106) is a silicon nitride layer or a silicon carbide layer; forming a dielectric layer (110a, 108b, 110b, 112) over the cap layer (108a); etching the dielectric layer (110a, 108b, 110b, 112) and the underlying cap layer (108a) using reactive ion etching to form a damascene opening (125) and expose the first metal layer (106), wherein impurities (127) are formed on the exposed first metal layer (106) and wherein the damascene opening (125) is a via having trench; performing a plasma treatment on the

exposed first metal layer (106) to remove the impurities (127) thereon, wherein the plasma treatment uses a hydrogen or a hydrogen-containing plasma and an oxygen containing plasma; and filling copper (125) in the damascene opening ([0030] – [0056]).

6. Claims 1-4, 6-9, 11, 15, 16, 26 and 28-33 are rejected under 35 U.S.C. 102(e) as being anticipated by Ngo et al. (U.S. 2002/0162736 A1).

Ngo et al. (Figs.3-12) teach a related method for forming a metal damascene structure including forming a cap layer (22) on the a metal layer (16), wherein the cap layer (22) is silicon nitride or silicon carbide; forming a dielectric layer (13, 14, 15) on the cap layer (22); etching the dielectric layer (13, 14, 15) and the cap layer (22) to form a damascene opening (16) and expose the first metal layer (10), wherein impurities (17, 19) are formed on the exposed first metal layer (10), wherein the damascene (16) opening is a via having trench; performing a plasma treatment on the exposed first metal layer (10) to remove the impurities (17, 19) thereon; and filling copper (53A) in the damascene opening, wherein the plasma treatment uses a hydrogen, a nitrogen plasma, a ammonia plasma and mixtures thereof ([0021] – [0030]).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 18-25, 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith et al. (U.S. 2003/0224595 A1) in view of Wu et al. (U.S. 2003/0022513 A1).

Smith et al. (Figs.3-12) teach a related method for forming a metal damascene structure including forming a cap layer (108a) over a copper layer (106), wherein said cap layer (106) is a silicon nitride layer or a silicon carbide layer; forming a dielectric layer (110a, 108b, 110b, 112) over the cap layer (108a); etching the dielectric layer (110a, 108b, 110b, 112) and the underlying cap layer (108a) using reactive ion etching to form a damascene opening (125) and expose the first metal layer (106), wherein impurities (127) are formed on the exposed first metal layer (106) and wherein the damascene opening (125) is a via having trench; performing a plasma treatment on the exposed first metal layer (106) to remove the impurities (127) thereon, wherein the plasma treatment uses a hydrogen or a hydrogen-containing plasma and an oxygen containing plasma; and filling copper (125) in the damascene opening ([0030] – [0056]).

Smith et al. fail to teach wherein the reactive ion etching recipe uses a fluorine-containing plasma or a chlorine containing plasma. However, Wu et al. (Figs.3A-3B) in a related method to form interconnects teaches providing a substrate (300); forming a cap layer (302) on the substrate (300); forming a dielectric layer (306) on the cap layer (302); etching the dielectric layer (306) by means of reactive ion etching using a fluorine-containing plasma recipe, wherein the plasma creates impurities on the dielectric layer (306); and providing a plasma treatment comprising a hydrogen containing gas, a nitrogen containing gas and an oxygen containing gas or mixtures thereof to remove said impurities from the dielectric layer (306) ([0021] – [0035]). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Smith et al. and Wu et al. to enable the etching process of Smith et al. to

be performed according to the teachings of Wu et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching process of Smith et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

9. Claims 34 and 36-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith et al. (U.S. 2003/0224595 A1) in view of Huang (U.S. 2002/0054962 A1).

Smith et al. (Figs.3-12) teach a related method for forming a metal damascene structure including forming a cap layer (108a) over a copper layer (106), wherein said cap layer (106) is a silicon nitride layer or a silicon carbide layer; forming a dielectric layer (110a, 108b, 110b, 112) over the cap layer (108a); etching the dielectric layer (110a, 108b, 110b, 112) and the underlying cap layer (108a) using reactive ion etching to form a damascene opening (125) and expose the first metal layer (106), wherein impurities (127) are formed on the exposed first metal layer (106) and wherein the damascene opening (125) is a via having trench; performing a plasma treatment on the exposed first metal layer (106) to remove the impurities (127) thereon, wherein the plasma treatment uses a hydrogen or a hydrogen-containing plasma and an oxygen containing plasma; and filling copper (125) in the damascene opening ([0030] – [0056]).

Smith et al. also teach using a resist to perform the patterning of the dielectric layer ([0030]), but fail to expressly teach wherein said resist contains carbon. However, Huang in a related method to form an interconnect structure teaches using organic photoresists as part of the patterning process in the formation of said interconnects

([0004]). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Smith et al. and Huang to enable patterning the dielectric layer of Smith et al. according to the teachings of Huang because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed patterning step of Smith et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

10. Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Smith et al. (U.S. 2003/0224595 A1) in view of Huang (U.S. 2002/0054962 A1) as applied to claims 34 and 36-40 above, and further in view of Wu et al. (U.S. 2003/0022513 A1).

The combined teachings of Smith et al. and Huang fail to teach wherein the reactive ion etching recipe uses a fluorine-containing plasma or a chlorine containing plasma. However, Wu et al. (Figs.3A-3B) in a related method to form interconnects teaches providing a substrate (300); forming a cap layer (302) on the substrate (300); forming a dielectric layer (306) on the cap layer (302); etching the dielectric layer (306) by means of reactive ion etching using a fluorine-containing plasma recipe, wherein the plasma creates impurities on the dielectric layer (306); and providing a plasma treatment comprising a hydrogen containing gas, a nitrogen containing gas and an oxygen containing gas or mixtures thereof to remove said impurities from the dielectric layer (306) ([0021] – [0035]). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Smith et al. and Huang with the teachings of Wu et al. to enable the etching process of Smith et al. and Huang to be performed

according to the teachings of Wu et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching process of Smith et al. and Huang and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

Response to Arguments

11. Applicant's arguments with respect to claims 1-9, 11, 15, 16 and 18-40 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

14. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (571) 272-1855. The fax number for this group is 703-872-9306 for before final submissions, 703-872-9306 for after final submissions and the customer service number for group 2800 is (703) 306-3329. Updates can be found at http://www.uspto.gov/web/info/2800.htm.

Julio J. Maldonado
Patent Examiner
Art Unit 2823

Julio J. Maldonado
September 28, 2004

George Fourson
Primary Examiner